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A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. L
No. 1279

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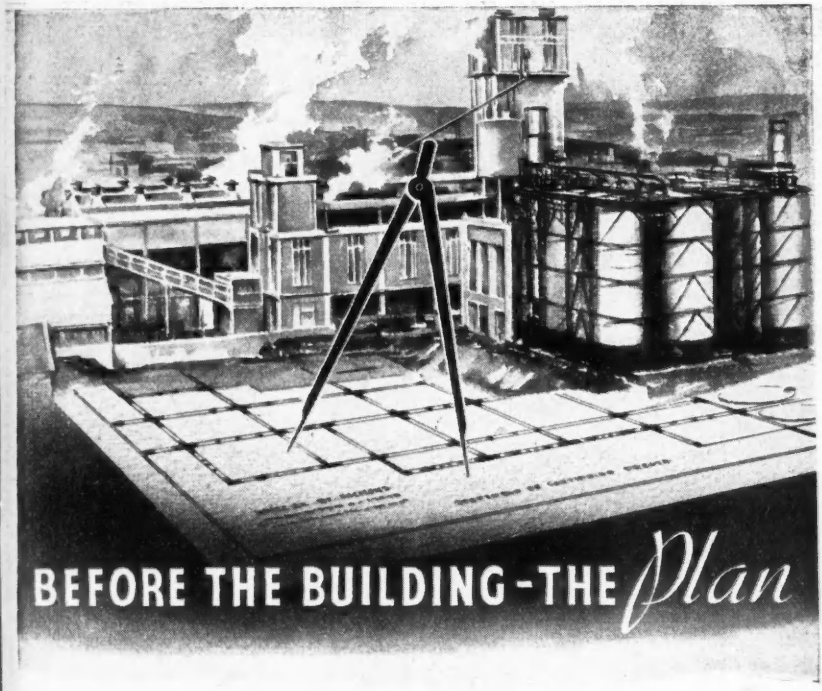

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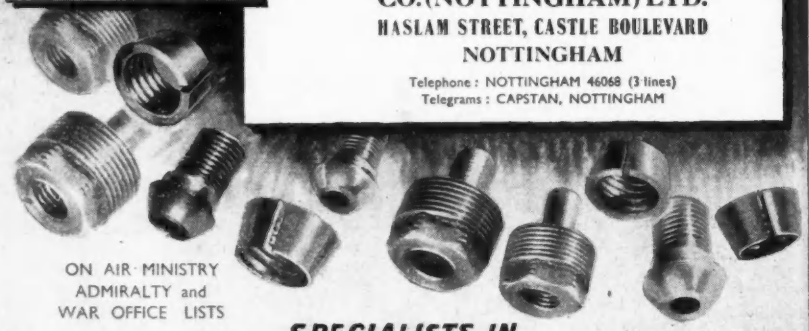

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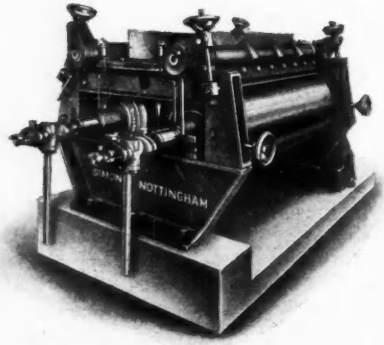

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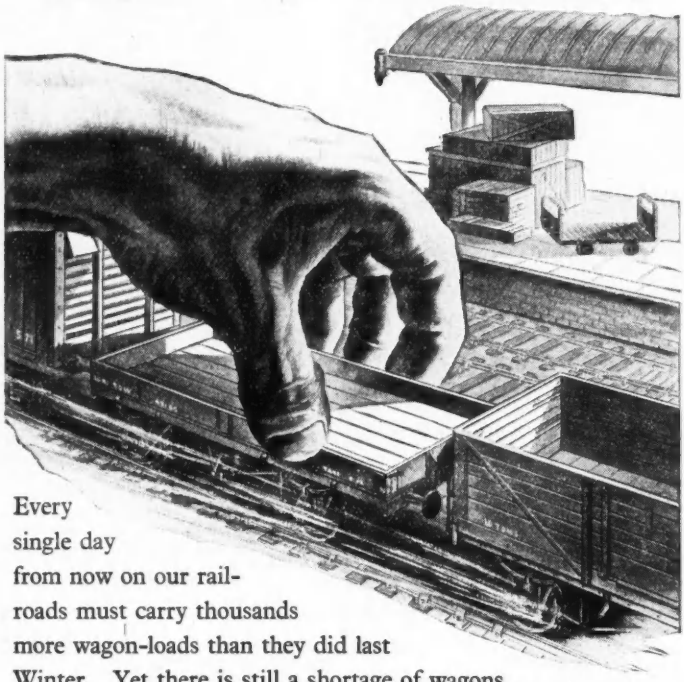

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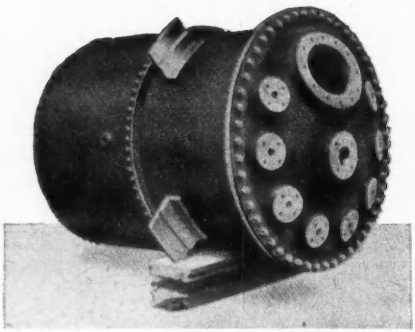

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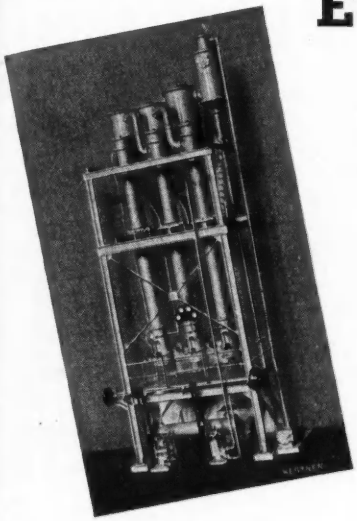

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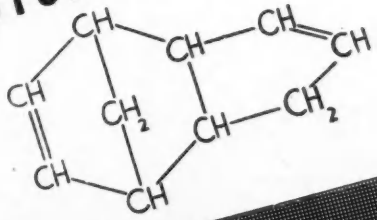

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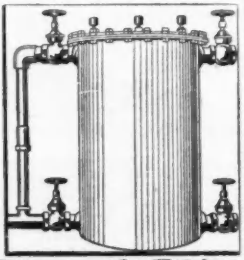

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Mineral Resources

IT is a difficult point to decide where the chemist ends and the metallurgist begins. The chemist is responsible for the production of metals from their ores, and the metallurgist for the working-up of the raw materials into commercial materials, but in the refining section of the process the borderline is indistinct. Many sciences combine in the development of mineral resources. The geologist and the prospector must discover them; the miner must win them from the ground; the chemist must obtain the metals from the ores; the metals must be refined; and the metallurgist must make them into steels, or non-ferrous alloys. In the development of mineral resources, however, there is one very important factor. Mineral deposits are a wasting asset.

The earth is composed of certain elements, and so far we have only been able to scratch about on the surface. The time may come when we may be able to tap resources several miles underground; even—looking a long way ahead—20 or 30 miles underground. The temperature, however, at this depth is beginning to get so high—it may even be red-hot — that very special methods would have to be used for artificial cooling. That, however, is a development of the very distant future, and, of course, the cost of mining at those depths would be absolutely prohibitive judged by modern standards. On the surface of the earth certain materials are very plentiful, but many of the minerals that are of economic importance have been concentrated in small areas. Supplies in these areas are not inexhaustible and already there is anxiety in regard to many of the deposits.

A British Association committee that was formed in 1942 to consider the mineral position has lately reported and, in the light of the present position, has emphasised the need for fuller information. We can, for example, see the duration of our present iron ore resources for only a few centuries ahead, and the reserves of certain metals, such as tin, are estimated to last for less than a century. It is evident that a systematic survey of the mineral supplies of the world is desirable, and there may have to be some form of international control. Many metals which were curiosities only a few years ago are now used in modern industry among these being aluminium and magnesium. The steel industry to-day requires nickel, chromium,

On Other Pages

Notes and Comments 3
Fuel Efficiency Lectures—III: Driers—Heat and Mechanical 5
Derivatives of Propylene ... 9
Parliamentary Topics 10
METALLURGICAL SECTION
Nitriding 11
Brass Cartridge Scrap 15
U.S. Search for Metals 16
A New Tantalum Deposit ... 16
Hardened Steel Balls 16
Personal Notes 17
New Control Orders 17
Letter to the Editor 17
General News from Week to Week 18
Forthcoming Events 19
Commercial Intelligence ... 19
Company News 19
Stocks and Shares 20
British Chemical Prices 20

molybdenum, tungsten, vanadium, and cobalt, which occur in workable quantities in comparatively few places. More than 80 per cent. of the world's nickel, for example, comes from Canada. The seriousness of the position lies in the fact that the industrial developments of the last century have led to a consumption of minerals on such a scale that the quantity required is approximately doubled each 20 years. We live in an age of substitution, and it may well be that plastics (derived partly from coal) and other materials of construction are likely to be used to replace certain metals and alloys for many purposes, but the fact remains that we must do something about our supplies of metals. We have been using all our raw materials too lavishly, and we have now reached the stage where care and conservation must take the place of prodigality.

It will not be forgotten that the discovery of basic steel has enabled the leaner iron ores to be worked and that a great deal is being done in improved methods of dealing with scrap. It may well be found that new processes will enable leaner ores in general to be used and will lead to greater recovery of valuable metals from the principal ores, but so far as we can see at present many metals and other minerals, such as mica and phosphates, are indispensable and will always remain so.

The suggestion has been made by the British Association that an international research association should be established as soon as possible after the war, for the purpose of collating existing information on the amount and geographical distribution of natural resources, of initiating surveys of resources not hitherto fully assessed, of reviewing technical methods with a view to making production more efficient, and of promoting research in such subjects where desirable. Such an organisation might deal with natural resources as a whole, but there is a strong case for beginning with mineral resources, which in some ways present a simpler problem than, say, the products of agriculture. The association could form the basis of a system of international control, which will be necessary to prevent the squandering of diminishing reserves and to ensure a fair distribution to consuming countries.

A practical point of some importance would immediately arise from the operations of this organisation. It would be possible, if a proper survey were made, to determine which minerals are likely to become in short supply, and to begin forthwith a search for substitutes. We have previously pointed out in these columns that British metallurgists have been remarkably successful in finding substitutes for many of the metals that were in short supply because of difficulties of transport or because their sources had been captured by the enemy. There is little doubt that we could find substitutes for many of the metals in which there is likely to be a similar difficulty for other reasons after the war. Clearly, the utilisation of products derived from agricultural crops, wood, or other inexhaustible sources of supply, is to be preferred to the use of metals and minerals which are likely to become exhausted in a comparatively short time. The Atlantic Charter has proposed that all states should have access on equal terms to the raw materials of the world, among which minerals occupy a very special position. Of course, although the greater part of the world's surface is now fully known, prospecting for new mineral deposits is by no means completely at an end: only this week, for example, we record a valuable new tantalum deposit in Brazil. But this, again, is a wasting asset.

It would seem from the facts here cited that the problem will be not so much to give all nations access on equal terms as to ensure that the materials available to mankind as a whole are put to the best possible use. During the past few decades an advance has been made within many nations, and particularly in the highly industrialised nations, from competition to co-operation. Before this war international competition was fierce, though attempts were being made to regulate it. The likelihood of difficulties in the supply of raw materials would appear to make it more likely that before many more years have passed international competition will have given way to international co-operation in the industrial sphere. We are somewhat too close to the making of history to see the implications of all that is happening, but we believe that these movements will be hailed by the historians of the future as giving to our generation a very special place in history.

NOTES AND COMMENTS

The Inside Story of Steam

"STEAM is industry's most wonderful, flexible adaptable tool. No self-respecting workman presumes to call himself by his craft name until he knows how to use and look after the tools of his trade. Yet steam, the beautiful heating and power tool, is spoilt, blunted, rusted, wasted by thousands of steam-users because they have never learnt how to use it, how to keep it sharp." That is the lively opening paragraph of an exceptionally interesting and useful description of steam for process and heating. It is an anomaly that such an everyday commodity as steam, the commonest raw material of industry, should be among the things least understood by the users of it. Simple evidence that it is not properly understood is to be found in many places, where process and heating steam pressures are still too high for the work they have to do. And there are more indications that, in spite of gathering knowledge of fuel usage, the virtues of steam as our most accommodating and most flexible medium for heating are still sadly neglected, misused or ignored. The booklet we have in front of us—Bulletin No. 25, issued by the Fuel Efficiency Committee of the Ministry of Fuel—sets out to put this right. We urge every steam-using managing director and every departmental executive concerned with steam usage for process or heating to get hold of a copy, to read it carefully and then to put their new-found knowledge to practical purpose in their plant.

The Use of Steam Tables

AFTER giving us the inside story of steam, the bulletin shows us how valuable are Steam Tables in "finding our way about" in the proper application of steam for any particular job. Most of us know just how unappetising these columns of figures appear. Yet, as the author of the bulletin says, "a totalisator looks worse than a steam table, but a couple of races are enough to show you how to lose. Learn your way about the steam table and you are bound to win. You can learn poker or snooker because you want to. If you make yourself want to, you can learn the steam table with just as little trouble, and, unlike cards, balls or horses, it will never let you down." Steam tables—the properties of saturated steam and superheated steam—are given in a useful appendix which includes also tables on the flow of steam through pipes; the useful heat and the flash from unit condensate; the percentage of flash steam from condensate; the superheating effect of wiredrawing; and pressure equivalents. Diagrams of the variation of boiling temperature with pressure; the advantage of low pressure steam for heating; and the percentage of flash steam from condensate are likewise included. We ourselves enjoyed reading this bulletin and learned much from it. If your interests in any way concern the use of steam for process and heating you ought, somehow, to find time to read every word of it.

The Forgotten Million

UNDER the above heading, Sir Ernest Benn writes in the London *Evening News*: I have searched through Ministerial speeches for a whole week—some twenty of them. None of them has a syllable to say about the business man; all would appear to assume that the species is defunct, and that life now and after the war goes, and will go, merrily along with committees and officials, "the business of everybody," as Macaulay said, being "the business of nobody." A grave injustice, for which the politicians are responsible, is thus done to the leading part played by the business man in the national war effort. Everybody—except the mentally blind—knows that we depend absolutely upon him, and that but for his high sense of duty the war would have been lost long enough ago. Our war industries have functioned in spite of official handicaps; our business men have maintained their factories, carried the whole of the usual heavy responsibilities, and, in addition, surmounted the many obstacles to production put up by people who may understand forms and figures, but in practical matters are as new-born babes. . . . There are, roughly, a million who can claim to be responsible men of business, and many more who have the necessary sense of responsibility and

want only the opportunity to use it. The heads of great concerns, the directors of combines, are often regarded as representative of the business world, and I sometimes think they get too much say in the matter. The whole lot of them, all put together, wonderful as they may be, account for no more than a small fraction of our trade; they all depend on hundreds of thousands of little concerns, with and through whom they do their business, and those little concerns may be said to be the very life-blood of our existence. It is high time that we began to talk business and think a little more of the business man.

The Identity of Antibiotics

IT must have struck many chemists, as more and yet more names of new mould-derived antibiotic substances have been added to the scattered literature of this subject, that some of these bacteriostatic agents might prove to be chemically identical. Evidence that this may be so is offered in a letter published in *Nature* (1943, *152*, p. 750) above the names of Dr. F. Bergel and five other research workers of Roche Products, Ltd. The facts set out there seem to indicate that clavatin, patulin, and claviformin may be identical. Clavatin is the product of the mould *Aspergillus clavatus*, and is probably the same substance as clavacin, mentioned in THE CHEMICAL AGE last week (p. 621). Patulin and claviformin are the metabolic by-products of two different species of the genus *Penicillium*—*P. claviforme* and *P. patulum*. Dr. Bergel and his co-workers find the empirical formula of clavatin to be $C_7H_6O_4$—the same formula as was suggested by Raistrick for patulin. From both of these substances, derivatives such as the acetate and the oxime have been prepared, and the melting points of the two parallel sets of derivatives are now found to be almost exactly the same. (Incidentally, the letter casts doubt upon the structural formula that has been proposed for patulin.) The evidence submitted is not conclusive, but it does open up a new line of thought. If the same antibiotic does happen to be produced by several different moulds, then there will be an opportunity of selecting the mould that gives the highest yield. The concentration of effort into the investigation of one particular mould instead of two or three would almost certainly result in earlier commercial production of the antibiotic concerned.

William Allen

THE firm of Allen & Hanburys, Ltd., is one of our best known drug houses. The story of William Allen, from which this concern derives half its name, is told in the Christmas number of the *Pharmaceutical Journal*, and an interesting story it is, too. William Allen, who was the first president of the Pharmaceutical Society, died on December 30, 1843, at the age of 73. Besides his association with pharmacy, he had a wide interest in science generally. As a scientist he came before the public eye with the lectures and demonstrations he gave on natural philosophy and chemistry at his pharmacy in Plough Court, London. So impressed was Sir Humphry Davy with the lectures, that he invited Allen to give a series of lectures at the Royal Institution. The invitation was accepted, and his talks in the lecture hall in Albemarle Street proved a great success. A few years later Allen was elected a fellow of the Royal Society.

A Versatile Scientist

THOSE were the days when scientists did not have to pay the high price of narrow specialisation which modern science demands of its practitioners, and Allen was able to find the time to participate in the foundation of the Geological Society, and also to be a keen astronomer! True, Allen used to rise at five, and not retire until midnight, but we doubt whether even a 24-hour day would make it possible for a modern astronomer or chemist to wander outside his own restricted field. The difference between Allen's day and ours is also brought home forcibly by the recollection that five of his associates at the Plough Court Pharmacy became fellows of the Royal Society; to-day, there are relatively few laboratories in Britain which could breed five F.R.S.'s within a lifetime, and certainly none concerned with pharmacy. At one time Allen was in partnership with Luke Howard, who, however, left to start a chemical business in Ilford, now known by the name of Howards and Sons, Ltd.

FUEL ECONOMY IN THE CHEMICAL INDUSTRY

Fuel Efficiency Lectures

III.—Driers: Heat and Mechanical

by F. R. FARMER

THIS introduction is designed to introduce some newer lines of inquiry, which will serve as a base for a strictly practical discussion. The materials to be dried fall into three main groups: (1) liquids, (2) pastes, filter-press cakes, etc., (3) crystals and powders.

A "liquid" may here be any free-flowing liquor, not only milk, water solutions, etc., but also clay slips and slurries. "Filter-press sakes" denotes a general class including materials from open-top filters, precipitated and settled pastes, and centrifuged and pressed materials.

Liquids

The result of drying liquids is in general a fine, freely-divided powder. Liquids should be concentrated as far as possible before drying. On a correctly designed and operated plant, evaporation is cheaper than drying. The concentration can be by thermal evaporation or mechanical separation. Evaporation must be used for solutions and should then be dealt with as a plain evaporation problem, outside the scope of this discussion. The use of mechanical separation must be carefully considered on a cost basis taking into account power, labour, and handling, etc., but should then only be chosen if a suitable drier is available to deal with the resulting product.

It is often easier and cheaper to dry from a smooth free-flowing cream than from a filter-press cake. This will be examined in Section 2 below, but an example is chalk or any similar product inert in character. When a cream containing 50 per cent. solids is dried on a rotary film or drum drier, one ton of powder per hour requires the evaporation of 1¼ tons of water and gives a fine free-flowing powder not requiring grinding. But if further settled or pressed down to 33 per cent. water, a pasty solid or cake is obtained which can be dried (a) in a rotary drier using air, (b) on hearths with rabble arms or stationary, (c) in tunnels, or (d) in cupboards. There are only 10 cwt. of water per hour left to evaporate, but of the total heat 33-40 per cent. is lost in outgoing air and 10-15 per cent. is lost by radiation, etc. The steam required is still 1¼ tons and the product is in lumps requiring further handling and grinding.

Enlarging on this example—if the material originally contained 70 per cent. water it would mean the evaporation of 2¼ tons of water as against 10 cwt., so that de-watering would be advisable. This is not the whole answer to the problem, as it may pay to re-wet it back to 50 per cent. solids, *i.e.*, the optimum concentration at which it will dry from a liquid to a finely-divided powder.

Press Cakes

The chief characteristic about drying this class of material is the slowness, drying time being from 2 hours to 2 days. The product is lumpy and requires grinding. Slow drying is inefficient, as a large plant is required to accommodate all the material being dried, *e.g.*, tunnels 100-200 feet long. This represents a high loss of heat by radiation, etc., and in batch plants there are losses by leakages of air, loading and unloading operations, and periodic cooling and heating of the plant.

A few of the main sources of loss of heat will be mentioned. The best operating temperatures must be used, *e.g.*, a high air-inlet and a low outlet of the tunnel type. The inlet air temperature should not be raised too high in an effort to obtain efficient evaporation—200-250° C. is the usual maximum, as higher temperatures cause high loss by radiation unless lagging is very efficient. The outlet air temperature should be some way above saturation point. Few changes can be made in a tunnel drier as the variables of size, length, etc., output, air temperatures, and velocity, are closely related.

The same principles are used in a cupboard drier except that this is a batch plant, and employs air re-circulation, with bleed off to atmosphere. A close check should be kept on this, and if possible adjustment should be made during the batch operation, *i.e.*, more fresh air at the beginning, and very little at the end, to correspond with the drying rate.

A point which has been found to be at fault in many plants is the volume and distribution of the air circulation. It is found that 80 to 90 per cent. of material may dry in twelve hours but it requires eighteen hours to dry completely, and usually the plant is left running till the whole batch is dry, to avoid mixing batches and to cut down labour cost. On one plant of 12 kW. hourly consumption, this means the wastage of 72 kW. for the excess time of 6 hours.

It is often difficult or impossible so to design the plant that each tray receives the right amount of air, say 2½/5/7½ ft. per second, to do its job. Baffles are used but are not sufficient; tray loading also causes

local variations. The answer is to increase the air circulation perhaps by 100 per cent., thus giving most trays an unnecessarily large volume of air but ensuring sufficient to the few.

On one plant, which was having electric heaters of 12 kW., the air volume was increased from 6000 to 12,000 cubic feet per minute requiring an extra 1 B.H.P. on the motor. For twelve hours' operation, this is 12 kW. as against the saving of 72 units due to the 6 hours reduction in drying time. The net saving is 60 units, which in turn means 30 tons of coal per annum. This is on a small plant and the gain may be 10 times as great on a large plant.

The solution to the difficulties in drying cakes lies in approximating to the conditions for liquid drying, *i.e., dry quickly* and finish with a free-running powder. Hitherto this has been impossible or difficult with most products, but can now be carried out with many materials on the TV drier. This drier now deals with cakes, crystals and powders which are aggregates of fine powder. The cake is dried when air-borne in a vertical column, disintegrates and exposes a very large drying surface, and dries in a few seconds, producing a free-flowing powder.

Methods of Heating

The usual sources of heat are electricity, gas, steam, or direct firing. There are often special reasons for adopting a particular method. Comparative costs for a typical plant are as follows: 12 kW, for 20 hours is 240 kW., 900 lb. steam, 8½ therms gas, or 70 lb. coke. The cost with electricity at ¾d. per unit = 15s., with gas at 8d. per therm = 5s. 8d., with steam at 7s. 6d. per ton = 3s. 2d., and with coke at 3s. per cwt. = 1s. 10½d.

Direct firing is the cheapest, but is usually ruled out, owing to contamination with dust. If contamination of one part per thousand is not serious, furnaces of a semi-producer type are available, which will keep a constant temperature at an atmosphere fairly free from ash. Filters are now available which can be used in hot gases at 1/10 in. to 1/4 in. water gauge, and reduce contamination to one part per ten thousand or better.

Electricity may be used to give higher temperatures than can be given by steam, *e.g.*, 200°-250°C. It is often possible to combine two methods of heating, such as steam to 160°C., then electricity. An instance was given of a saving by this method of £2 10s. per week or 40-50 tons of coal per annum for a 120-hour week, in which the temperature was taken to 160°C. by steam and from 160° to 200°C by electricity.

A further suggestion is the use of fluid heat transmission to give hot clean air at above steam heat, hot oil or other heat transfer medium direct fired by coal or fuel oil. The cheapest form of heat is that which is free on site such as flue gases. These can be used sometimes direct but more often *via* a heat exchanger to give the most economical drying.

It will now be apparent that the decision whether mechanical drying should be used or not must be taken after careful consideration of the form and characteristics of the press cake and available driers.

Discussion

Q. Is it possible to improve the efficiency of driers by reclaiming the latent heat in the outgoing water vapour?

A. The latent heat is available only at 50°-60°C., so that it could not be used to raise air or water to a higher temperature potentially. Usually a drier should be worked efficiently so that the outlet temperature is well below 70°, or possibly 80°C.

Q. Does not the capital cost of plant figure too largely in our calculations?

A. This has been the tendency, and inefficient plant has been installed to save capital outlay, although the difference is often outweighed in one or two years' operation. For post-war development the most efficient plant should be very carefully considered.

Q. Coke is said to be cheaper than steam for drying. Does that include the cost of handling?

A. Direct firing with coke is very much cheaper than steam heating, in the proportion of about 2 to 1, including handling. The possibility of using mechanical stokers with coke should not be overlooked.

Q. Waste heat in the form of flue gas is probably the cheapest medium for drying, but how can the fly ash be removed from it?

A. Interwoven glass fibre cloth might be used, though it may clog. The electrical precipitator is also very useful and can now be used at temperatures around 300°C. at which flue gases would be supplied to drying plants. Waste heat is not recommended for drying products which require absolute purity.

Q. What are the principal sources of inefficiency and particularly loss of heat which are to be found in drying plant?

A. (1) Surface not lagged; the loss by radiation, etc., from the surface may be 50 per cent. of the total heat consumption.

(2) Leakages of air—inwards or outwards; even a small gap in a door seam of ¼ in. may result in the loss of 15 or 25 per cent. of the heat.

(3) Temperatures too high; if the plant is efficiently lagged higher temperatures can be used with advantage. The outlet temperature from the drier is rather misleading because if it is kept very low, say 40° or 45°C., there may be an increase of drying time of 50 or 100 per cent., whereas an increase of 20°C. may so shorten the drying

time that the total of net heat units used is smaller.

Q. Is not the distribution of the gases in the drier important, since dead spaces will prolong the time of drying?

A. Every attempt is made to secure equal distribution, but inequalities of load and other imperfections make it difficult, so that a margin of 100 or 200 per cent. in the quantity of air used is generally allowed. The power required for moving the air is relatively small, but the heat required for keeping the drier in operation for longer periods may be very considerable.

Q. The lecturer has said that it is cheaper to evaporate 50 per cent. of water from a cream or suspension than to dry off much smaller amounts of water from the cakes produced by mechanical drying. It is true that many driers used for drying pastes are inefficient, but further information on this subject would be useful.

A. There are two types of drier to consider—air-heated driers and direct steam-heated driers. An air drier uses 60-70 per cent. of its available heat. With filter cake the dry material frequently requires further processing, and the cost of this must be added to the cost of drying. It is then cheaper to dry a cream on a suitable drier by steam heating than by air.

Balanced Draught

Q. Balanced draught is found in combustion practice to be a very satisfactory method of reducing air leakage. Has the same principle any application to drying for the same purpose?

A. The position of the fan in relation to the drier is important. It is best to have it as near as possible, but there may be pressure loss in the drier of perhaps 1 or 2 in., so that at some intermediate point there will still be air leakages, either positive or negative. If positive hot air is wasted by being blown out, or if negative cold air is drawn into the system and heated there, it is reasonable to have the drier as well balanced as possible, and attention should be paid to the air-tightness of doors.

Q. Which is the worse of two evils? the loss of fuel through having air leaking into the drier which is under suction, or the expulsion of air through leaks in a drier working under pressure?

A. The evil is decided by a dust nuisance rather than by a heat nuisance. Most people would certainly prefer to have air drawn in rather than blown out. One of the disadvantages of a system with air drawn in, is that one cannot estimate the quantity. It would be worth testing for leaks. This can easily be done by applying a lighted taper or by applying a positive pressure to the drier in question; this method would not be used, of course, where an explosive mixture was possible.

Q. From the point of air inleakage is it not better to put the fan on the pressure side rather than on the suction side?

A. A fan on the pressure side would be subjected to hot gases. The problem must be considered in the light of the pressures developed by the fan, and consequently of the resistance of the apparatus, because the extent of air inleakage would depend upon the difference between the pressures of the air inside and outside the drier. The most economical arrangement usually is to put the fan after the drier.

Q. Does the principle of placing the fan on the suction side still hold in the bleed-out system in which the air is circulating round and round the drier?

A. It is necessary to determine where a leakage is likely to occur (*e.g.*, at the doors), and to arrange for the pressure or suction to be lowest at these points. The fan is placed sufficiently far away to prevent high suction or low pressure.

Control Instruments

Q. Can an instrument be provided to show how much air is recirculated and how much is discharged through the drier?

A. This is a very important suggestion. It is very important that the proportion of fresh air and circulated air should be regulated according to plan and not left to the operator. At the beginning of the process it might pay to lead off 30 or 40 per cent. of the air used, but at the end almost all the air would be circulated internally. The rates might be controlled by a differential pressure gauge. Another control would be by hygrometer on the air outlet so that the operator would bleed off air in accordance with the humidity.

Q. Cannot drying ovens be controlled thermostatically so that the heat supplied would fall as the percentage of the moisture in the cake decreases?

A. Normally, the temperature rises from beginning to end of the process, but a thermostat could easily be employed for steam or gas heating, though it would not be simple to make it self-adjusting. Presumably the operator would have to be given a time-table for adjusting the thermostat.

Q. What is the most economical speed at which to circulate the drying medium?

A. The usual basis is a velocity of 5½-7 ft. per second over the trays at the temperature ruling, and to avoid dead spaces probably 100 per cent. should be added to the amount of air calculated in this way.

Q. In a continuous oven is the cross-sectional area taken as a basis for calculating the speed?

A. It must be ascertained how much of the space is taken up by the trays. Allow 5½ ft. per second over the surface exposed, and then double the answer so obtained.

Q. Is it feasible to put both the heaters

and the fan inside the oven, allowing a regulated current of saturated air to leak out from time to time?

A. It is better to put the heaters in the oven if it can be arranged. The arrangement of air circulation is most important in any drying system, the optimum velocity being 5½ ft. per second. The amount of air allowed to escape from the system should be sufficient to prevent the humidity from becoming unduly high, because with approach to air-saturation the drying time is very much extended.

Determining Humidity

Q. Can information be given as to the instruments for determining the humidity of the gases?

A. Several types of instrument are on the market. Only the wet-and-dry-bulb hygrometer is recommended as a standard method. It gives reasonably accurate results if a good air flow is maintained over a wet bulb and the wet bulb is kept clean.

Q. Can further information be given as to the rate of bleeding-off of salinated air from circulation heaters? A principle appeared to be that if air remains in circulation it must be fairly well saturated in a short time, and the drying capacity must be equal to the amount of air which was removed.

A. The amount of bleeding-off settles the capacity of the drier, but the rate of drying is determined by the amount of air circulated. It would serve no useful purpose to bleed off much air if the circulating rate was not sufficiently high to bring about evaporation. When any material is exposed on a tray the rate at which water will evaporate from it depends upon the air velocity, unless the end-point is being approached, when internal diffusion becomes important.

Q. Can some information be given on the drying of materials with chemically combined water.

A. This depends very largely upon the nature of the materials. It is found that when an inefficient form of drier has to be used, with an air-temperature outlet of 120°C., or even more, up to 200°C., it is difficult to decide whether to use continuous or batch driers. The batch system is clumsy, particularly in dealing with a large amount of material. The answer must depend upon the material in question. A continuous drier can be used if the exhaust heat can be taken to an earlier drying process, or if waste heat from furnaces is available.

Q. What is the difference in power consumption between comparable units with vacuum drying and hot-air drying?

A. On balance there is very little to choose between them on a large scale. A lesser number of heat units is used on most well-designed vacuum systems than on an air system, because of the loss of air blown away. The extra power required is usually made up in the difference in cost. I myself try to avoid using vacuum driers if possible, because there is some difficulty in operating them, and maintaining vacuum-tight joints, as well as maintaining easy access to the material. There is also difficulty in control of temperature; if it is necessary to work at temperatures lower than steam heat it is not always easy to provide heat by water at some lower stages of, say, 60° C. or 80° C.

Q. Is it preferable to take the air to the front of a furnace, or to a second chamber at the rear?

A. Only a proportion should be taken in the front. With most furnaces there should be enough primary air-flow for good combusion, with some extra air to ensure that combustion is reasonably complete, though without having extra air to chill the flame unduly. Secondary air might enter the furnace either from lower down in the front or from the back. If insufficient air is being drawn in from the front of the furnace then the furnace brickwork would become hot. If too much air is being drawn in at the front, combustion is usually bad

Summary of Discussion

The chairman, summarising the fuel economy aspects of the discussion, made the following points :—

(1) Absence of lagging would lead to a 50 per cent. loss of the total heat input. (He drew attention to the need for lagging generally not only any driers but other plant.)

(2) The proper control of combustion, or of whatever other means is used for heating is most important.

(3) Air leakages, either in or out, are a great source of loss of fuel.

(4) The outlet temperature should not be maintained too high, but it must be high enough to give a reasonably high rate of drying, since the extension of the time of drying would lead to loss of heat.

(5) Distribution of the air in the drier is important, and with existing driers this means attention to keeping the right volume of air pressing through it.

(6) The correct physical condition of the raw material in respect of its fluidity and water content should be watched; mechanical reduction of water is cheaper than thermal drying, but filter-cakes, etc., may be difficult to dry on account of their physical condition.

It is reported from New York that the ban on the publication of regular monthly copper, zinc, and lead statistics will soon be lifted, thereby putting an end to the war-time blackout that has been keeping the several industries in darkness.

Derivatives of Propylene

Important New Syntheses

RECENTLY-developed derivatives of propylene were among the products discussed by Mr. J. C. G. Boot in his paper presented to the joint meeting of the Institution of Chemical Engineers, the Chemical Engineering Group, and the Institute of Petroleum on the subject of "Petroleum as a Base Material for Chemical Industry." It was with propylene conversion, said Mr. Boot, that the petroleum chemists scored the most spectacular successes from a purely chemical point of view, and here the position of the oil industry is favourable, as there is little interference from other industries. It is true that conversion of propylene into chemicals does interfere to a certain extent with the requirements of the petroleum refiner, but in many areas the quantity of propylene may be sufficient to meet both needs. The variety of chemicals that can be synthesised from propylene is really impressive.

Acetone Production

Starting with sulphation and hydrolysis, we get isopropyl alcohol (with small amounts of isopropyl ether as by-product) which, on dehydrogenation, gives acetone. This was one of the first steps of the petroleum engineer into the chemical field. Isopropyl-alcohol acetone production from petroleum is now considerable, amounting to something like 150,000 tons a year in the U.S.A. From these products, other heavier solvents are easily derived, like diacetone alcohol, mesityl oxide, methyl isobutyl ketone (an excellent lacquer thinner) and isophorone (a good solvent for vinyl resins). All these are commercially produced in appreciable quantities. Apart from the application of all these products as solvents in numerous industries, they have found extensive use as base materials for chemical syntheses. For instance, acetone can serve for the manufacture of acetic acid and anhydride (*e.g., via* ketene) or for methacrylate manufacture *via* the cyanohydrin. Though many of the reactions of acetone have been thoroughly explored, it is of interest to note that renewed study by the research staffs of the large oil companies could still lead to the discovery of a series of hitherto unknown syntheses, based on acetone, frequently resulting in new products. One of these, a synthetic insecticide, is in production, while others seem promising in different applications.

Chlorination of propylene yields the dichlorides, while chlorhydrination gives propylene glycol. It is, however, the invention of hot chlorination which deserves most attention, as it has opened up a vast and highly interesting new field of organic chemistry. It is the synthesis of glycerol in this way, *via* allyl chloride (allyl alcohol) and the chlorohydrins, which has attracted most attention and has been claimed as one of the most important discoveries since Haber's ammonia synthesis. In the U.S.A., synthetic glycerol manufacture, however, has never materialised. Competition is difficult with a commodity which is a by-product of a certain industry and the most one can say now is that the possibility of synthetic glycerol manufacture may exercise a price-stabilising influence. However, the intermediates in glycerol manufacture and their derivatives may ultimately prove of greater interest to the petroleum chemist than glycerol itself.

It is almost impossible even to enumerate the potentialities of the allylics. Part of this story is told in *Ind. Eng. Chem.* (January to July, 1941). It is probable that their future will mainly lie in the field of plastics; examples are certain hard transparent resins, containing allyl groups, which are claimed to be superior to methyl methacrylate, and had it not been for scarcity of construction materials, commercial manufacture would perhaps have developed more rapidly. Further, various allyl resins hold great promise as coating materials and for laminates. Application of allylics in alkyd resins is also not unlikely. Allyl chloride and alcohol, various chlorhydrins and glycidol are already manufactured for such purposes and for intermediates in other syntheses. Acrylonitrile, used in Buna-N rubber, can easily be made from allyl chloride *via* the amine, acrolein from allyl alcohol. By-product chlorides obtained in the manufacture of allyl chloride are successfully used as soil fumigants. Cyclopropane, an anæsthetic, which can be made *via* halogenation of propane, can also easily be made from allyl chloride.

A new type of scrap-handling machine has been developed by the Alvey Ferguson Company, of Cincinnati, Ohio. The new machine segregates different kinds of metal scrap and dumps these into their respective bins, thus saving time, cost and man-power.

Recent R.A.F. raids on Berlin have resulted in severe damage to the Rheinmetall Borsig plant, the largest works of Germany's second biggest armament manufactures. On December 20, Bomber Command turned its attention to Frankfurt, and over 2000 tons of high explosives and incendiary bombs were dropped on the city's chemical and armament plants.

Parliamentary Topics

Research and Post-War Trade

IN the House of Commons Mr. Hutchinson asked under what conditions the Ministry of Works was prepared to grant facilities to firms engaged in the production of technical or scientific products to construct new research laboratories or to extend existing laboratories required to enable such firms to undertake the research necessary for the development of their post-war trade.

Mr. Hicks replied that, subject to the overriding demand of the Government building programme and of war damage and other essential housing works, sympathetic consideration has been given and would be given to applications to construct or extend research laboratories which had the support of the departments concerned.

Mr. Hutchinson: Does not the Minister consider that the existing procedure involves application to so many departments that it is very difficult to obtain a decision?

Mr. Lipson: How many applications have been received?

Mr. Hicks: I could not say at the moment how many have been received. Post-war problems have not so far been recognised as having priorities.

Portuguese Wolfram Exports

In answer to Sir Alfred Knox, the Parliamentary Secretary to the Ministry of Economic Warfare (Mr. Dingle Foot) said his department estimated that about half Germany's consumption of wolfram was now being supplied from Portugal. He wished it were possible for us to purchase the whole supply of wolfram from Portugal; at present we did purchase substantially larger quantities than the enemy.

Synthetic Rubber Production

Mr. Parker asked the Minister of Production whether he was aware that British Celanese had been granted licences for steel, iron and timber in connection with a plant for producing synthetic rubber in this country, involving both labour and materials which are in short supply, without the scheme having been technically investigated by the Synthetic Rubber Committee, who are experiencing difficulty in using synthetic rubber for truck tyres without a high proportion of plantation rubber; and why such licences were granted by his Department without scientific assurances that the project was technically sound.

The Minister of Production referred Mr. Parker to the reply he gave to Mr. Gallacher on December 3 (THE CHEMICAL AGE, December 11, 1943, p. 577).

Mr. Shinwell: Have not demonstrations of the use of synthetic rubber in the United States proved the serviceability of such material, and that it is in considerable use in that country? Is it not desirable that the Government should be encouraged to take the initiative in this matter, rather than that they should be impeded?

Mr. Lyttelton: I would like to see that question on the Paper.

Research in East Africa

Major Lyons asked the Secretary of State for the Colonies whether, following the recommendation of the Anglo-American Caribbean Commission in the case of the West Indies, he would arrange to set up an East African Co-ordination Research Council, to include representatives of Northern Rhodesia and Nyasaland as well as East Africa. Colonel Stanley replied that the question of providing such co-ordination was under consideration, but regretted that he could not make any statement about it.

Post-War Preparation

Mr. R. C. Morrison asked the Minister of Labour whether he was prepared to consider applications from manufacturers for permission to use a limited amount of skilled labour in preparatory post-war work.

Mr. Bevin: In present circumstances I can only agree to skilled labour being employed on preparatory post-war work if, in rare individual cases, special circumstances, such as health or hardship, make it impossible to call up the individuals concerned to the Forces or transfer them to essential work.

Mr. Morrison then asked Mr. Bevin whether he appreciated that, in view of the recent speech of the Minister of Reconstruction, this matter was giving great concern, because of the desire of employers to be ready, as they were urged to do by the Government, for when the war is over. Could he not arrange to consider special applications?

Mr. Bevin: Very much deeper considerations are associated with this problem than that, and I would rather not be pressed for a further answer.

Mr. John Dugdale: Is it not a fact that the United States are transferring a certain amount of labour to this type of work? It is my impression that they are doing so.—Mr. Bevin: That is one of the reasons why I do not want to say any more.

The Japanese are developing chemical industries in Java. According to the *Nieuwe Rotterdamsche Courant*, both tea and sugar factories are being turned over to chemical manufacture. The sugar factories, for instance, are now producing sodium nitrate and hydrochloric acid, chloride of lime, and sodium sulphate.

Metallurgical Section

Published the first Saturday in the month

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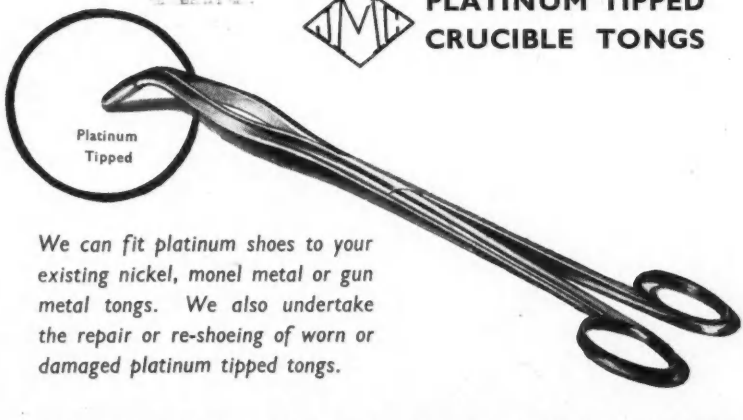

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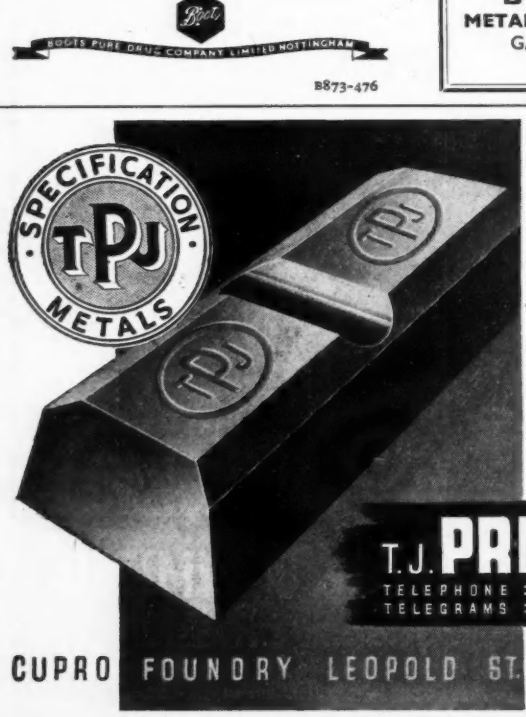

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Metallurgical Section

January 1, 1944

Nitriding

Case-Hardening Steels with Nitrogen

by L. G. WHYBROW PALETHORPE, F.I.C.

THE case-hardening of special steels with nitrogen, commonly known as nitriding or nitrarding, is a modern metallurgical process which has only been developed within the last two or three decades. Prior to that time it was generally believed that nitrogen had a deleterious effect on steel. In point of fact, it was in 1905 that Braune demonstrated that when iron was exposed to ammonia gas at 800°C. it absorbed nitrogen readily, giving a product much less resistant to shock and with reduced elongation in the tensile test.

The first systematic research on the effect of nitrogen on steels was carried out in Essen, in 1918, by Dr. A. Frey of Messrs. Fried, Krupp. He investigated its effect on iron, steel and on various other metals, and assessed the stability of their nitrides and the conditions under which these are formed. His work reached a climax when he introduced a series of special steels, collectively known as Nitralloy steels and standardised a nitriding technique, both of which will be discussed later. The special steels and the nitriding technique together form the basis of present day practice and are protected in many parts of the world by patents. In Great Britain the patent rights are held by Messrs. Nitralloy, Ltd., of Sheffield.

The nitriding process is a simple technique compared with the carbon case-hardening process. It consists of exposing heat-treated, finish-machined work made in special steels (Nitralloy steels) to the action of gaseous ammonia at a temperature of 500°C. for a predetermined length of time, dependent upon the depth of case required. The maximum exposure given in practice is 90 hours, which gives a case depth of approximately 0.030 in. Fig. 1 shows the rate of penetration of nitrogen.

Work required to be nitrided is placed in gas-tight boxes made of a heat-resisting alloy such as nickel-chromium or Monel metal. Each box is fitted with an inlet

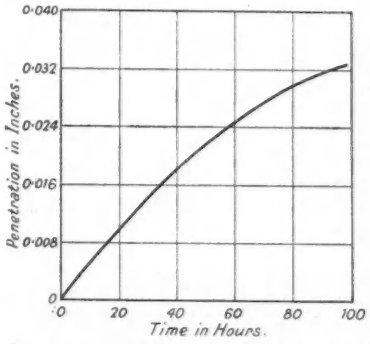

Fig. 1. Relation between penetration of nitrogen and time at 500°C. for ordinary Nitralloy steels.

and an outlet tube, usually made of nickel, for the passage of the ammonia gas. The work is loosely placed in position in the boxes. If it is small, it is packed in layers on nickel grids or gauze. The lids are placed in position and the boxes are sealed so that the access of air may be precluded. They are then charged into an electric furnace, the temperature of which is raised to and maintained at 500°C. until a suitable depth of case has been developed. Simultaneously, the gaseous ammonia is circulated over the work, by means of the inlet and outlet tubes. The gas may be supplied direct from a cylinder, and after passing over the work it is discharged through a wash-bottle, which indicates the flow and the back pressure. Fig. 2, overleaf, illustrates a typical nitriding unit.

When the time of exposure has been

completed, the furnace temperature is reduced quickly and the boxes are withdrawn, care being taken to avoid any influx of air. When the components are cool enough to handle they are unpacked, and on examination they are found to

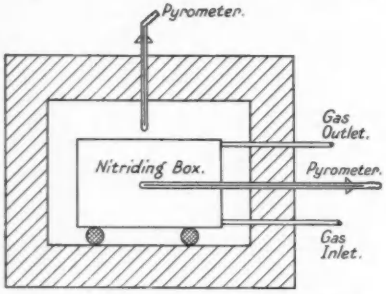

Fig. 2. Furnace arrangement for nitriding.

possess intensely hard surfaces. The nitrogen case is produced simply by exposure to gaseous ammonia. No quenching treatment is necessary, and the core properties of the steel are unaffected, provided that it has been tempered above 500 °C. beforehand. Generally speaking, then, the work is ready for use after treatment. There is, however, a slight growth during nitriding, and extremely accurate work is usually lapped or buffed before use.

Dr. Frey's early researches established the existence of several nitrides of iron. When the nitrogen content in the surface layer of steel is low, a solid solution is formed. As the concentration of nitrogen is progressively increased, two nitrides may be formed, Fe_4N first and then Fe_2N, containing 5.9 and 11.1 per cent. of nitrogen respectively. The conditions of formation have been examined and defined, and it has been discovered that nitrided steels undergo a peritectoidal change at temperatures from 580°C. upwards, the exact temperature at which the change occurs being determined by the alloy content of the steel—the higher the alloy content the higher the temperature of the peritectoidal change. Consequently, if nitriding is conducted below this critical temperature, most of the nitrogen is absorbed as a solid solution and not as a nitride.

In addition, Dr. Frey examined the effect of nitrogen on other elements when nitrided by the gaseous ammonia technique, and studied the nitrides formed on their surfaces. He observed, *e.g.*, that aluminium was notable both for the amount of nitrogen that could be absorbed and for the extreme stability of the resulting nitride. Chromium, vanadium, molybdenum, and tungsten are also strong nitride-formers; this is of special interest when it is remembered that these latter elements also readily form carbides. As a result of his observations, Dr. Frey prepared a series of alloy steels containing one or more of these metals, and studied the nitrogen cases produced on exposure to ammonia gas. His investigation led him to recommend alloy steels containing aluminium and chromium as the principal alloying elements.

Modern Nitralloy steels are primarily aluminium-chromium-molybdenum steels, designed for use in the heat-treated (sorbitic) condition. They are made in four carbon ranges to cover tensile strengths from 35 to 90 tons/sq. in.

The grade of steel chosen depends, of course, on the core properties desired. The point to remember, however, is that these steels are, almost invariably, heat-treated prior to nitriding. This involves oil-quenching, followed by tempering above the nitriding temperature. The resultant sorbitic structure is most sensitive to the nitrogen treatment.

The molybdenum present in Nitralloy steels is added partly because of its

Grade No.	Carbon %	Chromium %	Aluminium %	Molybdenum %	Ultimate Tensile Strength tons/sq. in.	Yield Point tons/sq.in.	Elongation per cent. on 2 in.	Reduction of Area %	Izod Impact Value ft./lb.
1	0.45–0.55	1.4–1.8	0.9–1.3	0.10–0.25	70–90	55–80	10–16	30–50	20–40
3	0.35–0.45	1.4–1.8	0.9–1.3	0.10–0.25	55–65	43–55	16–22	45–55	30–50
5	0.25–0.35	1.4–1.8	0.9–1.3	0.10–0.25	40–55	28–42	22–30	50–65	40–70
7	0.20–0.25	1.4–1.8	0.9–1.3	0.10–0.25	35–45	25–35	25–35	55–70	50–90

Fig. 3. Chemical and physical properties of some Nitralloy steels.

susceptibility to the nitriding technique, but more so because it wards off temper-brittleness due to the presence of chromium. Occasionally, nickel is present too, but this metal does not contribute to the hardness of the case through absorption of nitrogen ; on the contrary, it tends to reduce the case-hardness, but it toughens the core by forming a solid solution in the ferrite constituent. In addition, during the nitriding treatment, precipitation-hardening occurs, a nickel-aluminium compound being formed. Sometimes, too, sulphur and selenium are added to Nitralloy steels to render them free-machining.

In considering the nitrided case it is both natural and expedient to compare it with the case produced by carburising. The first point of importance is that the former is already hard, and does not require to be quenched, as does the latter. Equally noteworthy is the fact that the case produced by the nitriding treatment is the hardest ever produced by the case-hardening of steel, being of the order of 900-1100 Brinell as compared with the 650-700 Brinell of carbon case-hardened steels and tool steels.

However, in contrast to the carburised case, the nitrided case falls off in hardness

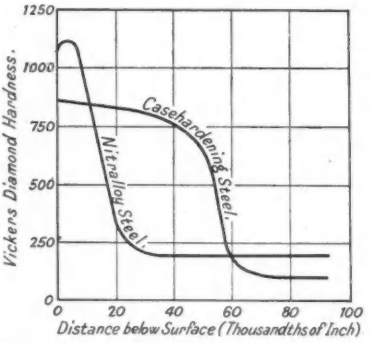

Fig. 4. Hardness penetration of nitrided and carburised cases compared.

at a more rapid rate. While this is of vital importance for some work it does not matter in all applications and does not, therefore, preclude its use in many fields. The economic limiting depth of the nitrided case is 0.03 to 0.035 in., whereas carburised cases may penetrate much deeper without undue length of treatment. Fig. 4 shows the comparative hardnesses of nitrided and carburised cases, and their relative fall with respect to penetration.

The extreme hardness concomitant with the nitrided case lends to it a very much increased resistance to wear. In the automobile and aircraft industries,

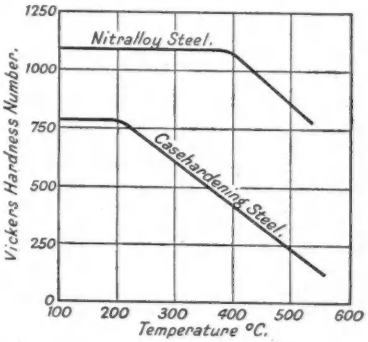

Fig. 5. Retention of surface hardness of Nitralloy and case-hardening steels at elevated temperature—for 24-hour exposures.

nitrided cylinder liners have given a remarkable life, and the polished nitrided surface allows anti-friction devices to be eliminated as it does not heat up when running with the light alloys.

The nitrided case differs very greatly from the carburised case in that it is capable of retaining its hardness at elevated temperatures. It will be remembered that the hardness of the latter falls off gradually above 200°C., whereas the former does not soften appreciably below 400°C. Even at 550°C. the hardness of the nitrided case exceeds that of high-speed steel. Fig. 5 illustrates hardness-retention at high temperatures.

Many practical applications based on this property are found in the realm of engineering science. For example, shafts running in faulty bearings may become very hot ; carburised steel would quickly soften and seize up, with serious consequences to the machine, whereas nitrided steel does not soften and therefore does not seize up.

A further useful property of the nitrided case is its resistance to the corrosive action of such agencies as fresh water, sea water, steam, etc. The resistance is most

marked when the work is put into service direct from the nitriding box without any grinding or lapping. The typical grey superficial film appears to have the greatest power to resist attack. It is a fact of some importance that while maximum corrosion-resistance is obtained on the skin, the maximum hardness is not developed until 0.001 in. or so has been removed. Nitrided steel is thus useful in applications where corrosive liquors containing abrasive particles have to be handled.

It has been reported that the weakening effect of notches and scratches is greatly reduced in steels that have been nitrided. In addition, nitrided steels retain their fatigue-strength under corrosive conditions to a greater extent than do carburised steels. Thus, for certain applications, nitriding can furnish a steel both extremely hard and inherently resistant to corrosion-fatigue, a combination of properties not readily developed in the more corrosion-resistant steels.

The Mechanism of Nitriding

The mechanism of nitriding is simply explained. At elevated temperatures, ammonia gas partially dissociates into nitrogen and hydrogen according to the equation : $2\ NH_3 \longrightarrow N_2 + 3\ H_2$.
On the surface of work to be treated, the molecular nitrogen dissociates catalytically to give " nascent " nitrogen, which alone is capable of uniting with the elements present in the steel. It will be remembered that below the peritectoidal change point the nitrogen tends to form a solid solution and above it tends to form nitrides. Normally, the dissociation is about 30 per cent. at 500°C. Under working conditions, regular analyses of the exhaust gases should be made as a guide. A simple eudiometric method of doing this depends upon the solubility in water of ammonia compared with the insolubility of its dissociation products.

The process, as previously described, is much simpler and cleaner to work than the carburising process with its various subsequent quenching techniques. There is no possibility of warpage or quenching cracks because the method involves no quenching operation. A little distortion however, is almost unavoidable unless the work is ideally uniform in section ; to minimise this, all work should be freed from internal stresses before nitriding. Generally, work is hardened in oil and tempered at about 500°C. ; failing that, it should be carefully normalised. Nitrided work invariably " grows " a little during treatment, usually about 0.001 in. This growth is quite uniform and can be allowed for in the absence of grinding.

Since nitriding has so many advantages over carburising the question may be asked, Why does the former process not replace the latter ? The writer would answer it as follows. In the first place, the nitriding process is protected by patents and can only be carried out by a few licence-holders. This necessitates sending work away to be treated, with consequent delay in production. Were the work to be carburised, it could be done on site, since very few works are without the necessary equipment. Secondly, labour costs are lower in comparison with carburising but material costs are higher ; consequently, small work may often be much cheaper when nitrided, but large work is usually dearer.

Often only part of a component is required to be hardened, in which case some method of selective nitriding must be employed. The following methods have proved satisfactory :

(1) Excess stock, usually 1/16 in. or more, may be left on the " required-soft " areas to be ground off after treatment.

(2) The " required-soft " areas may be tinned or soldered, using a zinc chloride flux. The protective layer should be as thin as possible to prevent any tin from melting off and falling on to areas required hard. The recommended procedure is :—clean, flux, apply tin and brush off excess.

(3) Nickel plating may be used, but a fairly heavy deposit is required to give satisfactory results.

Recent Developments

During the last few years, alloy steels other than the Nitralloy steels proper have been nitrided. The idea has been to develop hard surfaces on the tough engineering steels, so combining two very valuable properties for use on special duties. Chromium-nickel-molybdenum, vanadium-chromium-nickel and even austenitic chromium-nickel steels have been treated for special applications with measured success. It must be remembered, however, that the hardness obtained is never quite as high as when the straight Nitralloy steels are used.

Brass Cartridge Scrap*

An Important Aid in Copper Conservation

IN view of the tremendous amount of brass going into the manufacture of ammunition, the utilisation of cartridge scrap is a problem of vital importance to every user of copper alloy. Present-day cartridge brass is of two distinct types: (a) hot rolled, with a maximum allowable lead content of 0.02 per cent. and a preferred content of about 0.01 per cent., and (b) cold-rolled, with a maximum allowable lead content of 0.07 per cent. and an actual content of 0.05 per cent. Scrap of these two types can be readily segregated during the various stages of fabrication, but once the shell or cartridge case is finished, further attempts at identification are futile from a practical viewpoint and all fired-case scrap must be considered as suitable only for remelting into alloys having a lead content of 0.07 per cent. or higher. It is for this reason, among others, that suggestions to increase the allowable lead content in ammunition strip brass have had to be discarded.

Salvage from battle scrap increases as an army advances and decreases as it retreats. Hence, large tonnages of fired cases are now being returned for treatment and recovery. Shell cases from naval action are also recoverable and about the only real losses in this category are cases from aircraft ammunition fired over enemy territory.

Re-use for Cartridges

The best use for fired cases is, of course, re-sizing and re-loading for military re-use and this is arranged wherever possible. Other uses are always subject to the fundamental principle of conservation that scrap must not be downgraded, or in this specific instance, that low-lead-content cartridge scrap must not be wasted in the manufacture of high-lead alloys. Consequently, a preferable method of use would be to re-melt the scrap in the brass mills into slabs and bars suitable either for rolling into more cartridge strip or for fabricating other alloys of relatively high purity. Re-use as cartridge brass, unfortunately, is not as simple a matter as it might appear because of the low impurity limits that must be maintained. As much as three-quarters of the furnace charge may already consist of fabrication and ordnance-plant scrap, and simple mathematics will show that the remainder cannot be made up of fired case with a possible lead content of 0.05-0.07 per cent. unless the metal produced is to be cold-rolled. Since only one-third of the ammunition strip production is cold-rolled, it is obvious that at best only a limited amount of cartridge scrap can be consumed in this manner.

Greater possibilities are offered by certain new processes, by which satisfactory cases are being made from hot- and cold-forged cartridge brass rod made entirely from scrap, and by some upgrading of free turning-rod scrap into forging rod of intermediate lead content. The possibilities of these two methods are not as yet fully developed, and further complications are introduced because, in melting cartridge-case scrap in the brass mills, the more extensive handling and the longer melting times that are required waste both man-power and melting facilities.

The "Certified Ingot" Plan

The solution of these difficulties leads directly to the third alternative, melting the scrap in reverberatory furnaces and pouring the melt into standard-sized ingots which can then be analysed individually and either used directly for rolling or else re-melted in the brass mills. This so-called "Certified Ingot" plan would simplify the melting problem considerably, but is not altogether practical because of the difficulty of maintaining even an approximately uniform analysis such as would be needed either for direct rolling or brass mill re-melting. Because of the comparatively high zinc content of the alloy and the large free surface of the reverberatory bath, zinc losses would be heavy and the analyses difficult to control. In addition, melting capacity of the type needed is at present well occupied in the refining of new copper and the production of alloy ingots for foundry use. However, even including the necessity of building new furnaces, this plan is probably the most practical of those suggested.

Some cartridge scrap can be utilised in high-purity casting alloys but, unless zinc losses are to be excessive, or a large amount of virgin copper is to be used, this possibility is limited to manganese bronzes of 100,000 lb./sq. in. and 65,000 lb./sq. in. tensile strength since these are the only low-lead alloys in the low-copper range widely used to-day. Several thousand tons per quarter are now being thus utilised, and the desirability of a still more pronounced shift in this direction has been emphasised in a special "Conservation Chart for Brass and Bronze Castings."

It will be seen, however, that it is impossible to use up all the fired cartridge-case scrap which, in the long run, will contain the equivalent of about one-quarter of the total copper supply, in any combination of uses, which cannot constitute more than one-eighth of this supply. Large

* From a report by the American Society of Metals.

amounts of this type of scrap will, therefore, still be available for disposition in suitable end-products. As there is already an adequate supply of leaded scrap for both free turning-rod and casting demands, only one real course is left, unless the "Certified Ingot" plan proves adequate.

Returned battle scrap is just as much a part of the United Nations' copper reserve as are the stocks of mined copper ore and the copper ore lying in the ground. However, this battle scrap is both above ground and alloyed with zinc and can therefore be regarded from a different point of view. At present the battle scrap is retained in order not to "waste" it, while at the same time the next generation's ore reserves are being mined and refined into virgin metal. Would it not be preferable to save the actual ore reserves, especially those in the so-called "low cost" mines, and to utilise the refinery capacity so released to melt and refine instead the new reserves of battle scrap? From melting would come "Certified Ingot" material, while refining would provide both high-purity copper, to augment the new supply, and zinc oxide, capable of being sintered and mixed with the zinc ores which are also being used up more rapidly than future reserves indicate to be advisable. Only refineries with suitable bag houses for collecting the zinc oxide must be so used, of course, in order that both vital metals can be recovered.

U.S. SEARCH FOR METALS

The U.S. Bureau of Mines is sending teams of mineralogists and geologists into thirty states and Alaska in quest of a number of metallic ores which are vital to war production. The search will range from north of the Arctic Circle to Texas and from Maine to Washington State. The work includes examinations of industrial diamond areas of Arkansas, exploration of coal fields of Nevada and Oregon, a search for quartz crystals and more than a dozen other important minerals, including copper, asbestos, zinc, mercury, tungsten, vanadium, beryllium and other pegmatites, corundum, molybdenum, manganese, tin, iron, chromium, bismuth and nickel.

The search for zinc and copper is adjudged most important in the new hunt, with twenty-six zinc and twenty-one copper explorations scheduled. Owing to the greater demand for radio-grade quartz crystals for war-time communications systems, the Bureau will examine quartz deposits in four states to ascertain whether satisfactory commercial-grade material can be obtained. At present virtually all the quartz crystal suitable for radio-frequency control is imported into the United States.

A New Tantalum Deposit

Discovery in Brazil

A DEPOSIT of that rare metal, tantalum, has been discovered in Brazil; the mineral form in which it is found there is claimed to have a richer tantalum content than any so far known. Its occurrence is reported from Picui and Currais Novos, on the boundary between North Rio Grande and Paraiba, in a dike of pegmatite.

The mineral is of a honey-yellow colour, has a tetragonal crystalline structure and a density of 7.10 to 7.30. Its optical properties show that it is a distinct new variety of mineral. Spectrographic and chemical analyses indicate that it is essentially a meta-tantalate of aluminium, calcium, and magnesium. It consists of approximately 92 per cent. tantalum pentoxide, containing possibly 1-2 per cent. columbium pentoxide. The aluminium and calcium oxides average about 3 per cent. each and the magnesium oxide is usually from 2 to 3 per cent. Commercial possibilities of this new mineral are believed to be very promising in view of its high tantalum content and its exceptional purity. According to the report of Professor Leonardos, who submitted the specimens for analysis, it is very probable that the deposit will be able to produce a sufficient quantity of mineral for export.

Hardened Steel Balls

Tests for Wear

AN investigation, lasting for 15 months, of the wear of steel balls in a cylindrical ball mill used for grinding ores in the Transvaal gold-mining industry, has recently been described in the *J. Chem. Met. and Min. Soc. S. Afr.*, by T. K. Prentice. The test mill was 30 in. in diameter by 17 in. long. Sets of 3-in. and 2½-in. balls were run for periods of 5 days, 13½ hours, and the speed of the mill was 30.5 r.p.m. At the end of each run, the reduction in volume of the balls was measured.

The balls which gave the best life were made of a forged steel of the following analysis: C 0.90, Mn 0.89, Cr 0.8/1.0, Si 0.22 max., S 0.035 max., and P 0.025 max. The hardness was 350/400 Brinell. The tests showed, generally speaking, that the most durable balls were within the following analytical limits: C 0.6/0.9, Cr 0.85/2.1 or Mn up to 2.5. It was observed from the tests that wear (in terms of loss in weight) which reduced the diameter of balls from 2½ or 3 in. to 1½ in. was directly proportional to the square of the diameter (in other words the loss in weight was proportional to the surface area of the ball). Below 1½ in. the wear was slower and tended to bear out the theory of E. W. Davis that the loss in weight is proportional to the cube of the diameter.

Personal Notes

MR. H. H. BAGNALL has been appointed to the board of Lever Brothers and Unilever, Ltd.

DR. JOHN DUCKWORTH, biochemist at the Rowett Research Institute, Aberdeen, for 10 years, has been appointed a senior lecturer at the Imperial College of Agriculture, Trinidad.

MR. EDWIN D. WHITELOCK, M.I.Chem.E., chief engineer, and MR. LAWRENCE WEAVER, commercial manager, have been appointed directors of Brotherton & Co., Ltd., Leeds. MR. F. H. S. MCDAVID, C.A., has been appointed deputy-chairman of the company.

DR. VAN L. BOHNSON, one of America's leading chemists in the development of acetate-rayon production, has retired from the post of director of acetate research to the du Pont Company. He is succeeded by his assistant, MR. FENTON H. SWEZEY.

MR. J. C. CLARK, a chemical worker of Norton-on-Tees, is one of the four British trade unionists now visiting the United States on a six weeks' goodwill tour of war plants. On their arrival in New York they were received by Mayor La Guardia at the City Hall.

The 1944 recipient of the Perkin Medal, which is awarded each year by the American section of the Society of Chemical Industry, will be MR. GASTON F. DUBOIS, who is vice-president in charge of the research and development department of the Monsanto Chemical Co.

MR. K. HEADLAM-MORLEY has resigned from the position of Deputy-Controller of Chrome Ore, Magnesite, and Wolfram in the Ministry of Supply and has accepted an honorary appointment in a consultative capacity with the Iron and Steel Control. He will continue to act as Secretary of the Iron and Steel Institute.

MR. ROY A. HUNT, president of the Aluminum Co. of America, Pittsburgh, has received the Medal for the Advancement of Research, awarded annually by the American Society for Metals. The award of the Society's Gold Medal has been made to DR. ZAY JEFFRIES, technical director with General Electric Company, Cleveland.

In the absence of any further nominations the committee members of the British Section of the Society of Leather Trades' Chemists for 1944 are as follows:—President, D. BURTON, M.B.E., D.Sc., F.I.C.; vice-president, F. H. QUINN, M.Sc.; hon. treasurer, D. BURTON, M.B.E., D.Sc., F.I.C.; committee, M. P. BALFE, Ph.D., B.A., F.I.C., L. GOLDMAN, Ph.D., B.Sc., A.I.C., R. F. INNES, F.I.C.; chairman of technical advisory subcommittee, N. L. HOLMES, F.I.C.; hon. secretary, G. H. W. HUMPHREYS.

New Control Orders

Export of Chemical Plant, Oils, etc.

The Board of Trade has issued the Export of Goods (Control) (No. 10) Order, 1943 (S.R. & O. 1943, No. 1717; price 9d.), the chief effect of which is to consolidate previous Export Control Orders. The new Order comes into force on January 15.

The existing licensing requirements in respect of chemical plant have been withdrawn but the Order extends control to cover autoclaves, centrifugals and hydro-extractors, digesters and emulsifiers, and in addition the item relating to agitating, separating, and screening machinery has been modified.

The item relating to refractory blocks, bricks and tiles has been replaced by the item "Refractory blocks, bricks and tiles of chromite, chromite-magnesite, dolomite, magnesite or silica." The item relating to oils, fats and greases has been replaced by the item "Oils, including sulphated (sulphonated) oils, fats and greases, not specified elsewhere in this schedule and mixtures (other than medicinal preparations) wholly or mainly of such oils, fats or greases." The note relating to export control on amino and other basic organic compounds has been deleted but the schedule has been amended to specify the salts of such compounds. In the case of certain chemical preparations which previously appeared in the schedule under both the B.P., name and a brand name the latter has been deleted.

LETTER TO THE EDITOR

Wages in the Chemical Industry

SIR,—Our attention has been called to Press publicity concerning recent decisions of the Heavy Chemical Joint Industrial Council which agreed, among other matters, to the payment for statutory holidays. The statement says "such payments operate for the first time in the history of the industry." Such a statement is contrary to the facts and entirely misleading. Imperial Chemical Industries have, since agreement with various unions in 1938, paid level time for all statutory holidays and double time for all work performed on such days.

Apart from this, many principal firms in the chemical industry have for years paid workers for statutory holidays, and double time, not time-and-a-half, for working, either voluntarily or under agreements with the C.W.U. Taking the chemical industry as a whole, payment for statutory holidays and double time for working has been long-standing in the best firms in the drug and fine chemicals, soap, and paint and varnish sections.—Yours faithfully,

ARTHUR J. GILLIAN,
General Secretary, C.W.U.

December 24, 1943.

DETROIT PUBLIC LIBRARY

General News——From Week to Week

The suggestion is made by the Amalgamated Engineering Union that selected parties of British workers should visit the battle zones as a valuable stimulant to industrial morale.

Seventy tons of rose hips were collected in Scotland in 1943, compared with 40 tons in 1942. The total collection of foxglove leaves and seeds was 21½ cwt. Vitamin-C-containing syrup from the 1943 collection of hips is already available for children.

In Essex, the advisory chemists attached to the county war agricultural committee have analysed over 10,000 soil samples during the past eleven months; of these, 60 per cent. required lime. Out of 3952 samples, 1751 were found to be deficient in phosphate.

British Emulsifiers, Ltd., has during the past year acquired the whole of the share capital of W. and A. Williamson and Co., radiator manufacturers and sheet metal workers. This has involved an important extension of the company's interests in the aluminium industry, which now embrace the manufacture of secondary aluminium alloys, the production of aluminium castings, and the fabrication of sheet aluminium products.

A canteen run in connection with a factory is, for derating purposes, a factory or workshop. That decision was given by a King's Bench Divisional Court last week. The court allowed, with costs, an appeal by Simmonds Aerocessories (Western), Ltd., against a decision of the Rating Appeal Committee at Glamorgan Quarter Sessions that their canteen was not an industrial hereditament within the meaning of the Rating and Valuation (Apportionment) Act, 1928.

The Minister of Food has made two Orders consolidating the Invert Sugar (Maximum Wholesale Prices) (No. 2) Order of 1940, with the amending Order of 1942, and the Liquid Glucose (Maximum Prices) Order of 1941, with that part of the Glucose (Control) Order of 1940, which is still operative. The new consolidated orders came into force on December 26, 1943. The maximum prices for invert sugar and liquid glucose remain unaltered.

Expansion and up-grading of many existing technical institutions is advocated in a letter from Sir Eugene Ramsden, M.P., to the *Yorkshire Post*. He suggests, for instance, that serious consideration should be given to raising Bradford Technical College to university status. After the war we must make every effort to attract young people from both Empire and foreign countries to take up technical studies at British institutions, he adds, as such a course offers the opportunity of creating good relations between ourselves and the rest of the world.

In addition to the bulletin on steam mentioned in our editorial pages, the Fuel Efficiency Committee has also just published Bulletin No. 27 on "The Control of Air Supply for Combustion." All owners of boiler plant or industrial furnaces should note, and act upon, the vital points on the question of air supply with which it deals. It is just as readable as its predecessors, and is written, in the main, in non-technical language.

Sir George Nelson, president of the Federation of British Industries, in a New Year message, says: "If 1943 was the year of promise, 1944 may well prove to be the year of fulfilment. Industry is proud of the men and women who have carried on so steadfastly in the workshops of Britain. One day it will be possible to tell the story more fully. Meanwhile, we shall keep at our task of helping to provide the people at home with the necessities of life and the gallant men of th United Nations with the equipment for victory."

Possible changes in the methods of ship construction by the use of light alloys, with strengths comparable with that of mild steel while being only about one-third its weight, were outlined by Mr. W. Muckle, Lecturer in Naval Architecture at King's College, Newcastle, in a paper which he read at last week's meeting of the North-East Coast Institution of Engineers and Shipbuilders in Newcastle. Mr. Muckle said these alloys were past the experimental stage, and if 200 or 300 tons of structural weight could be saved, resulting in a decrease of deadweight of some 5 per cent. or more, their use seemed justified.

Foreign News

Cafelite, the plastic obtained from coffee by H. S. Polin, is being produced in a pilot plant installed in S. Paulo, Brazil, by the Departamento Nacional do Café.

A five-year research programme, to cost $2,500,000, has been announced by the American concern, Bituminous Coal Research, Inc.

The demand in the U.S.A. for Mycoban propionate salts, used to prevent mould growth in bread, cheese, butter and other foodstuffs, was doubled during the first six months of this year.

A synthetic resin reinforced with woven glass cloth manufactured by the Owens-Corning Fiberglas Corporation is being used in American production of self-sealing tanks for combat planes.

In consequence of an agreement between Brazil and the U.S.A., production of castor seed in Brazil has been greatly stimulated and reached 260,000 tons last year, against 167,000 tons in 1937, which was the year with the highest production before the war.

Forthcoming Events

On **January 3,** at 2.30 p.m., Professor C. R. Harington will deliver the Jubilee Memorial lecture of the **Society of Chemical Industry,** on the subject of "The Contribution of Chemistry to Immunology." The meeting will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.

A lecture by Mr. J. K. Parkinson, B.Sc., on "Aluminium Pigments" has been arranged for the meeting of the Hull section of the **Oil and Colour Chemists' Association,** at 12.45 p.m., on **January 4.**

The Midlands section of the **Electrodepositors' Technical Society,** will meet at 5 p.m. on **January 4,** at the James Watt Memorial Institute, Birmingham, to hear a paper by Mr. A. F. Brockington on "Barrel Plating."

The fifth group of fuel economy lectures arranged jointly by the **Association of British Chemical Manufacturers** and the **British Chemical Plant Manufacturers' Association** will be delivered in London on **January 5.** The meeting will take place at 2.30 p.m. in the lecture hall of the Geological Society, Burlington House, Piccadilly, and the lecturers are Dr. E. G. Ritchie, of the B.C.U.R.A. ("Peak Loads") and Mr. H. F. Barnes, of Negretti & Zambra ("Measuring Instruments"). Non-members are invited, and should notify Mr. A. J. Holden, A.B.C.M., 166 Piccadilly, W.1, at least a day before the meetiing.

Mr. E. L. Luly, B.Sc., will give a paper on "The Heat Content of the Products of Combustion," at the meeting of the **Institute of Fuel,** to be held on **January 6,** at 2.30 p.m., at the Institution of Mechanical Engineers, Storey's Gate, Westminster.

A paper by Dr. A. R. Lee and Mr. H. E. Carter, on "The Use of Wet Aggregate in Bituminous Road Construction" will be read to the meeting of the Road and Building Materials Group of the **Society of Chemical Industry,** to be held at 1 Grosvenor Place, S.W.1, on **January 6,** at 4 p.m.

The **Society of Chemical Industry,** Midlands section, meets at 5.30 p.m., on **January 6,** in the Chamber of Commerce, New Street, Birmingham, to hear a paper by Dr. W. D. Scott, on "The Raw Material Potential and Its Relation to the Trend of Synthetic Resin Development."

A meeting of the **Oil and Colour Chemists' Association,** Midlands section, will take place in the Colmore Room, Grand Hotel, Birmingham, on **January 6,** at 2.30 p.m. An informal lunch will be followed by a film show comprising two sound pictures: "Pipeline, Crude Oil Storage and Refining of Oil," describing some of the activities of the Anglo-Iranian Oil Co., Ltd., and "The Discovery of a New Pigment," the I.C.I. film about the development of Monastral Blue.

The Chemical Engineering Group of the **Society of Chemical Industry** and the **Institution of Chemical Engineers** are holding a joint meeting in the apartments of the Geological Society, Burlington House, Piccadilly, S.W.1, on **January 11,** at 2.30 p.m., when Mr. A. J. Andersen will lecture on "The Manufacture of Margarine."

At the Manchester meeting of the **Institute of Fuel** arranged for **January 12,** at 2.30 p.m., in the Engineers' Club, Albert Square. Dr. E. S. Grumell, chairman of the Fuel Efficiency Committee of the Ministry of Fuel, will deliver a résumé of his Melchett lecture. This paper, which will deal with fundamental questions of national fuel policy, will be followed by a discussion.

The Plastics Group of the **Society of Chemical Industry** and the **Faraday Society** will hold a joint meeting, to which the London section of the Oil and Colour Chemists' Association is invited, on **January 12,** at 2 p.m., at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. A symposium on "Molecular Weight and Molecular Weight Distribution of High Polymers" will be opened by Professor H. W. Melville, F.R.S.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Satisfaction

BRITISH DIESEL OIL & PETROL CO., LTD. (formerly L. T. C. DISTILLATES, LTD.), Gawber. (M.S., 1/1/43.)—Satisfaction December 8, of debenture registered April 4, 1938, to the extent of £6000.

Company News

Dussek Bros., Ltd., with a final dividend of 8½ per cent., are paying a total of 12½ per cent. for the year (same).

The **Universal Grinding Wheel Co., Ltd.,** are paying an interim ordinary dividend of 10 per cent. (same) on January 5. No final was paid last year.

Powderloys, Ltd., manufacturers of metal and plastic powders, etc., have increased their nominal capital beyond the registered capital of £10,000, by the addition of £140,000, in £1 ordinary shares.

New Companies Registered

Spray-Dried Foods, Ltd. (384,300).—Private company. Capital: £100 in £1 shares. Food and beverage manufacturers, manufacturing chemists, analysts, compounders and blenders of foodstuffs, chemicals and essential oils, etc. Subscribers: J. Dyer; C. R. G. Young. Registered office: 120-122 Victoria Street, S.W.1.

Chemical and Allied Stocks and Shares

MODERATE improvement of business in the stock and share markets has been reflected by firmer conditions in British Funds and also in industrial and kindred shares. Sentiment was assisted by the continued progress of the Prime Minister's health, and also by the view that during the next few months the Government's intentions in regard to post-war problems are likely to be more clearly defined.

In accordance with the general tendency, shares of chemical and allied companies have well maintained the prices current a week ago, and in some instances small gains were shown. As happened in 1942, industrial securities generally have not held the best prices recorded, but they have shown further gains on balance for the year. Imperial Chemical, which were 33s. at the end of 1941, and 37s. at the end of 1942, are now 38s. 9d. Highest and lowest levels recorded for I.C.I. ordinary in the past twelve months were 39s. 10½d. and 36s. 9d. respectively. Lever & Unilever, now 35s., had extremes of 38s. 6d. and 32s. 4½d. in 1943. In the case of Turner & Newall, now 78s. 6d., the limits were 81s. 1½d. and 72s. 3d. Borax Consolidated fluctuated between 33s. and 38s. 3d., and are now 35s. 10½d. Associated Cement (1943 highest and lowest, 67s. 6d. and 54s. 4½d.) are now 63s. 1½d. In many cases yields are small on the basis of last year's dividends. But sentiment is influfluenced not so much by the latter as by the hope that after the war there may be a return to the pre-1940 dividend levels; although it is recognised that this may be a gradual process, particularly as for some time there may be little modification of the practice of placing a large proportion of profits to reserve funds. In many cases the dividend outlook after the war may turn in a large measure on whether there is then an early reduction or abolition of E.P.T. Moreover, taking a long view, prospects generally will naturally be dependent on the success achieved in securing full employment of the country's resources after the war.

Contrary to the general tendency, shares of companies connected with the iron, steel and other heavy industries are closing 1943 not much above the lowest levels touched in the year. This is not due to expectations of any early reduction in dividends (with few exceptions, they are generally expected to be quite well maintained), but reflects uncertainty as to the post-war prospects. In the case of United Steel the year's highest and lowest were 27s. 4½d. and 24s. 4½d., and the current price is 24s. 9d. Consett Iron 6s. 8d. units had extremes of 8s. 6d. and 7s. 1½d. in the past twelve months; the current level is 7s. 3d. Elsewhere, Tube Investments have held their recent rally and are 91s.—within 5s. of the highest price in 1943. Stewarts & Lloyds, now 52s. 6d. moved between 49s. 9d. and 54s. 10½d. in the past year.

In other directions, Boots Drug, whose 1943 extremes were 44s. 3d. and 38s. 4½d., are now 41s. 6d. There has been considerable interest in shares of companies connected with plastics, particularly in Thomas De La Rue ordinary, which showed a sharp reaction from the highest price touched in 1943, but the current level of 158s. 9d. compares with the year's lowest of 83s. 1½d. British Industrial Plastics 2s. shares have moved between 4s. 10½d. and 7s. 3d., and the current level is 6s. 6d. Erinoid 5s. ordinary had 1943 extremes of 10s. 3d. and 12s. 10½d., and are now 10s. 6d. The units of the Distillers Co. are now 88s., which compares with highest and lowest levels of 90s. 6d. and 82s. during the past twelve months. Textile shares are well above the year's lowest and in many cases are not far short of best prices touched in 1943. Bradford Dyers (extremes 23s. and 14s. 3d.) are now 22s. 3d. British Celanese fluctuated sharply, but attracted considerable demand at times owing to the possibilities which may attach to the widening of the company's interests and activities.

British Chemical Prices

Market Reports

QUIET conditions prevail in most sections of the industrial chemicals market with the general tone steady. Contract deliveries are going forward on a normal scale but there has been a slackening of interest in new business with the approach of the close of the year. Taking the market on the whole, prices are expected to be maintained at recent levels and such alterations as may be made are likely to show an upward rather than a downward tendency. The supply position in most sections of the market continues to be one of the chief factors but certainly there has been no deterioration as compared with the position twelve months ago. The coal-tar products market finished the year on an active note and in most departments buying orders are in excess of available supplies.

MANCHESTER.—While Lancashire & York-

shire users of heavy chemical products have resumed their takings against contracts on a fair scale, the Manchester market has made slow recovery after the holidays so far as new bookings are concerned and it will probably be some days yet before trading conditions are back to normal in this respect. With regard to prices, these generally are on a very firm basis in virtually all sections. The outstanding movements have been advances of 20s. per ton in both precipitated carbonate and precipitated sulphate of barium. In the tar products section, fresh buying interest has been relatively slow, but most classes are being steadily absorbed against contracts.

GLASGOW.—In the Scottish heavy chemical trade there is no change from last week, home business remaining steady. Export trade is still rather limited. Prices remain very firm with a tendency to advance on certain commodities at the beginning of the year.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

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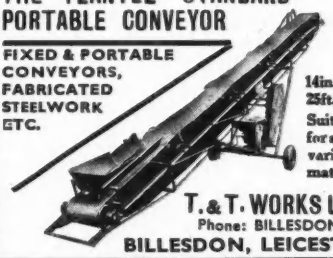
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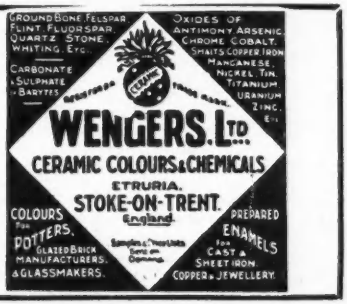
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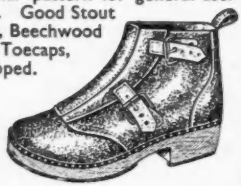

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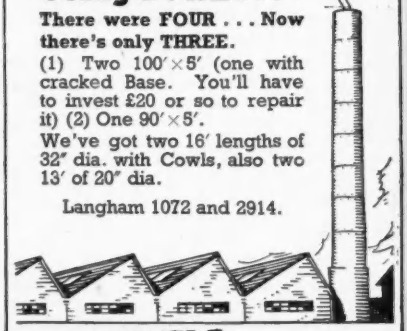

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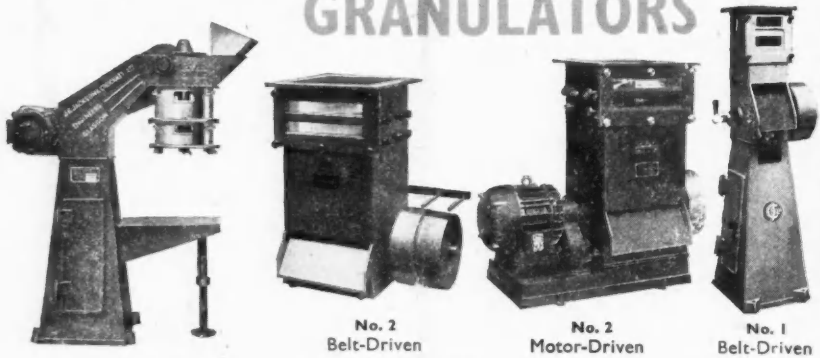

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